

**This is Exhibit "A" referred to  
in the Affidavit of RENUGA GOPAL  
Relating to U.S. Patent Application 10/743,562**

**And**

**sworn before me this      day of September, 2007**

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**A Commissioner for taking Affidavits**

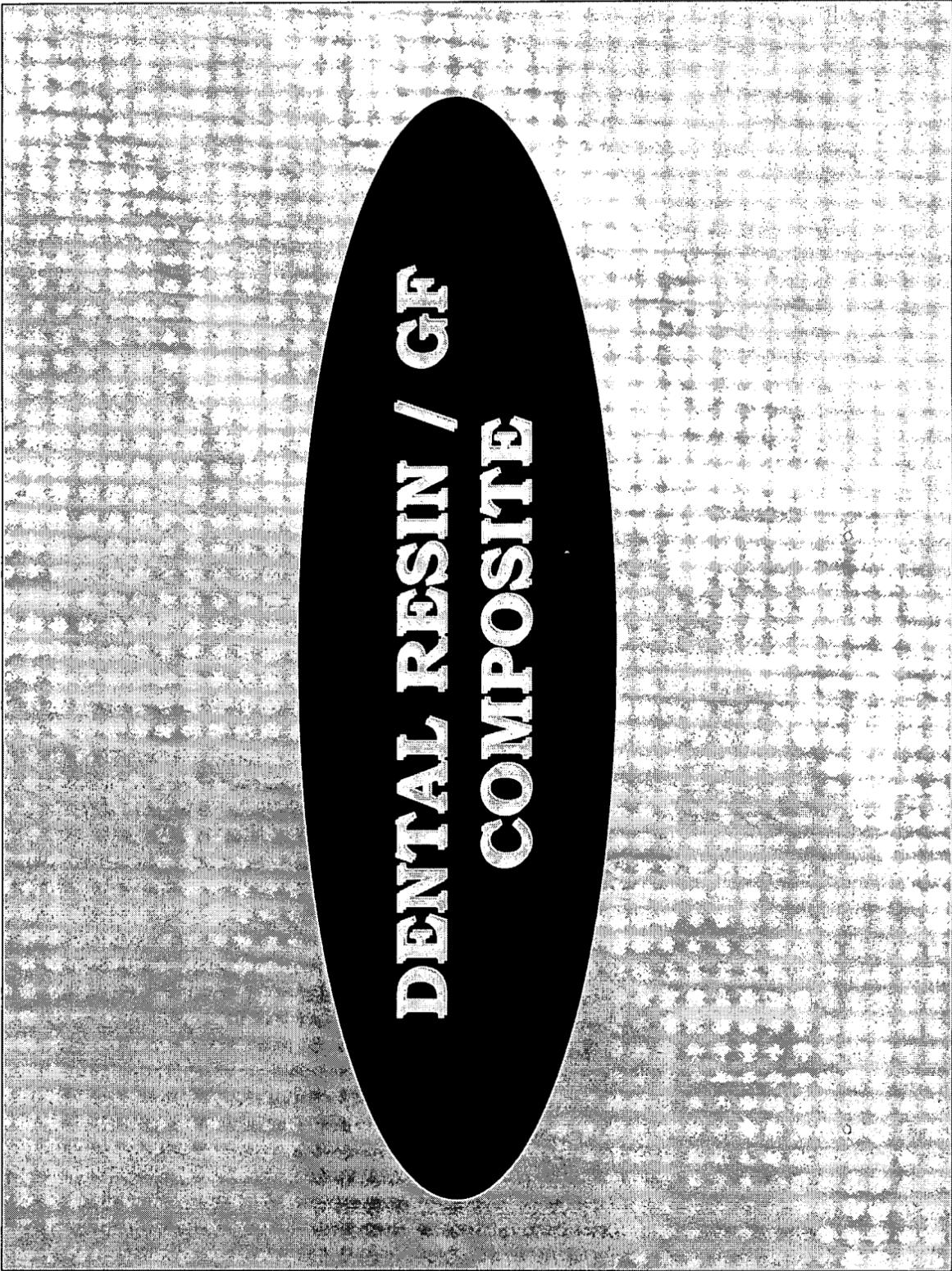
# **COMPOSITE ORTHODONTIC ARCHWIRE**

**PRESENTED BY: RENUGA GOPAL**

**DATE: 19<sup>TH</sup> OCT 2001**

# CONTENTS

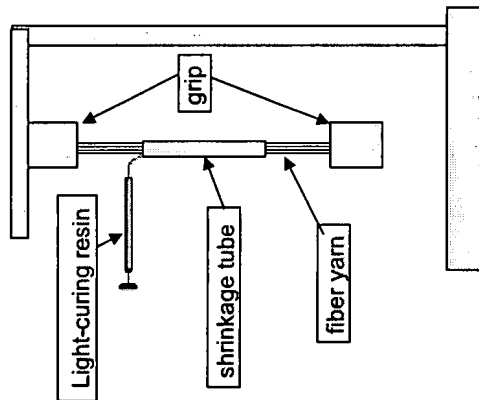
- **Material System**
  - Dental resin + GF
  - Epoxy resin + GF
- **Fabrication Method**
  - Optimal procedure
  - Surface Treatment of Glass Fibers
- **Testing**
  - Bending characteristics
  - Recovery of Wires
- **Future Work**



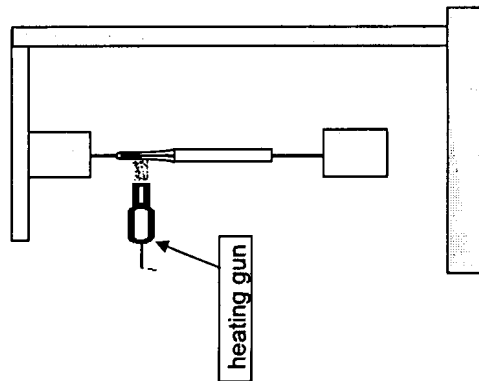
**DENTAL RESIN / GF  
COMPOSITE**

# Std Fabrication Method for GF/Dental Resin Wires

Glass fibers, brushed with resin, are inserted into tube and hung from a support bar. Light-curing resin injected into the tube to fill it up.

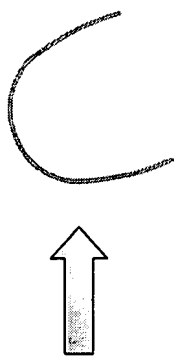


Heat applied using a heating gun. Both ends are heated. Tube vacuumed. Excess resin is heat-shrunk. Excess resin is held in tension.

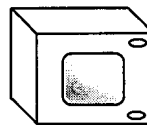
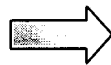


Specimen shaped into desired profile and placed in a light-curing chamber for 2 minutes. Shrinkage tube removed.

Specimen preformed into desired arch

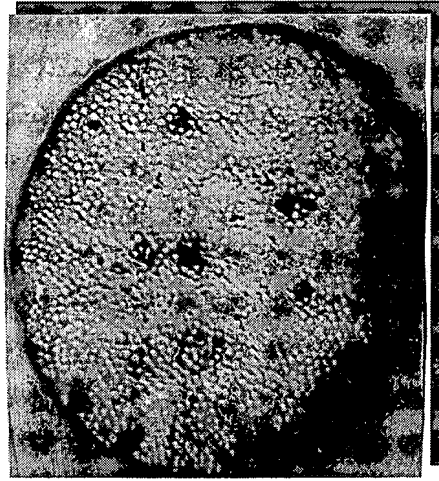


Specimen after shrinkage



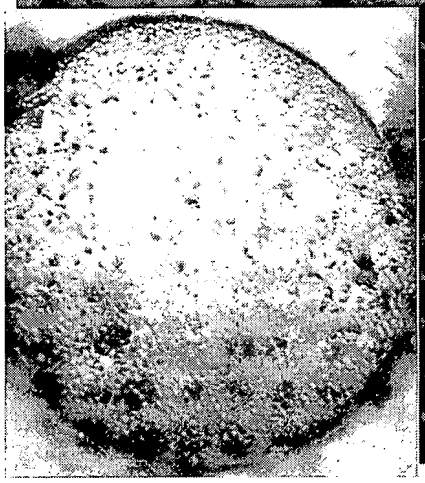
Archwire light-cured in chamber. Tube removed.

# CROSS-SECTION



## MTD I

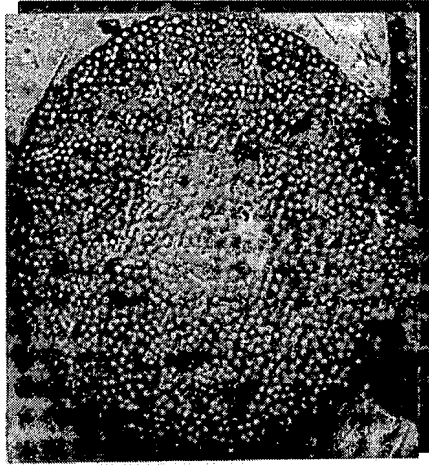
1. Insert tube and fill
2. Heat shrink



## MTD II

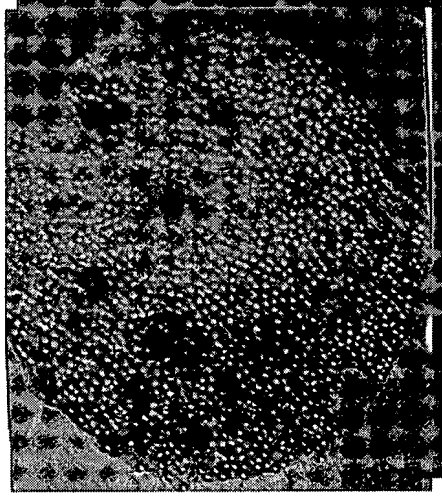
1. Brush GF
2. Insert tube and fill
3. Heat shrink

# CROSS-SECTION



## MTD III

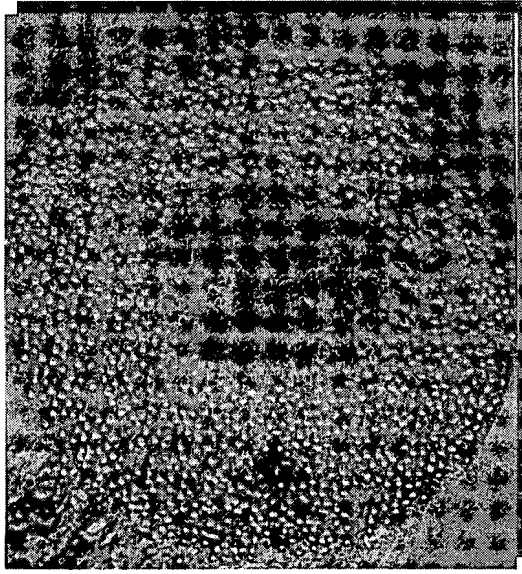
1. Brush GF
2. Insert tube and fill
3. Vacuum
4. Heat shrink



## MTD IV

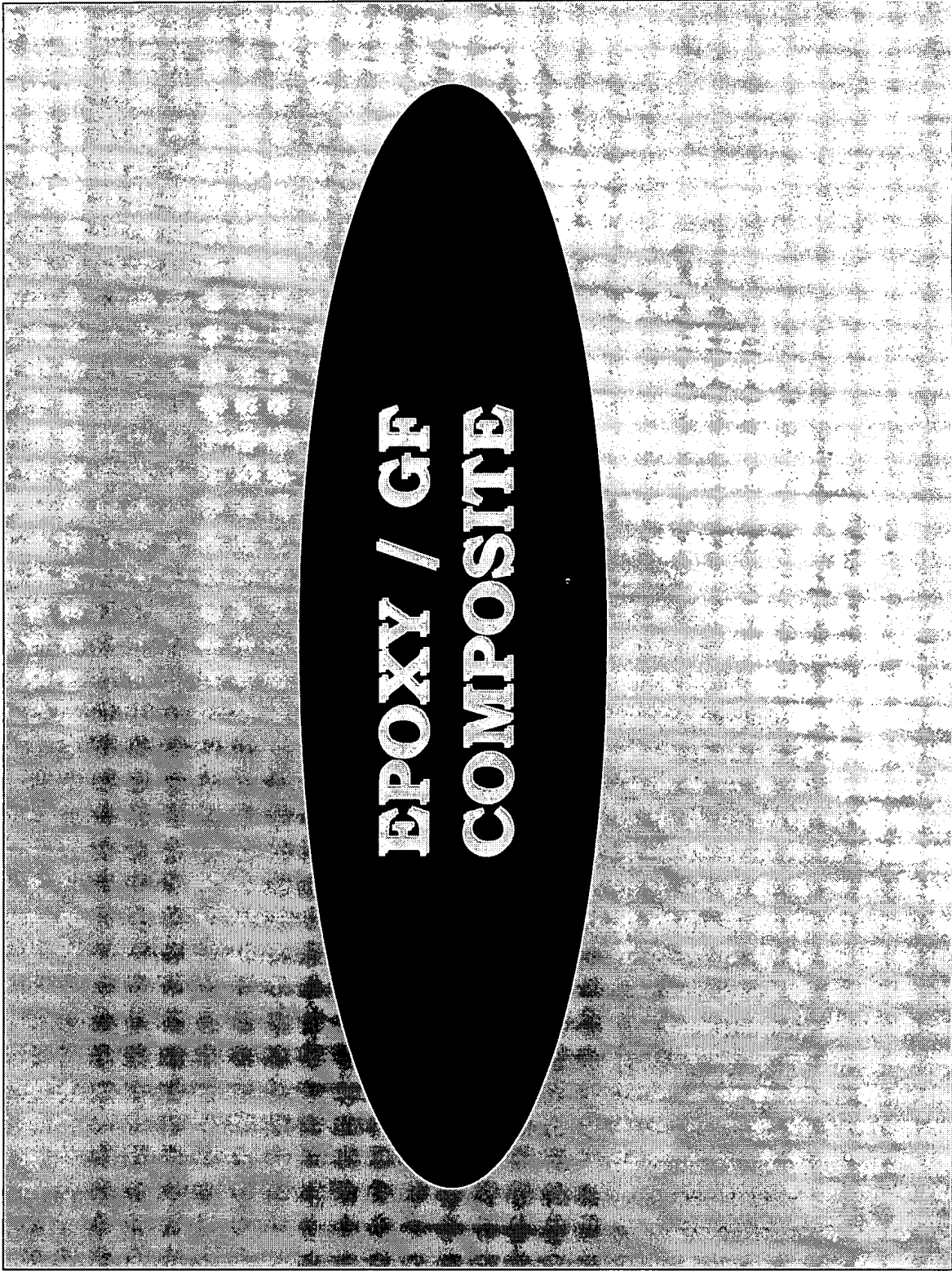
1. Brush GF
2. Insert tube and fill
3. Heat shrink
4. Vacuum

# CROSS-SECTION



## MTD V

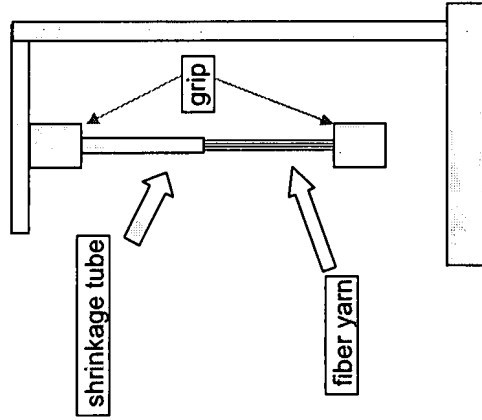
1. Brush GF
2. Insert tube and fill
3. Heat shrink the ends 1<sup>st</sup>
4. Vacuum
5. Heat shrink the whole tube



# Std Fabrication Method for GF/Epoxy Wires

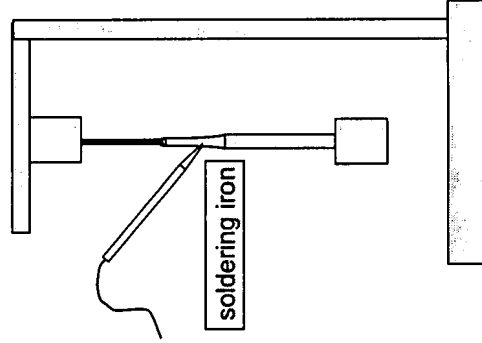
1

Hang the glass fiber from the support bar, and coat the glass fibers with the resin using a brush.



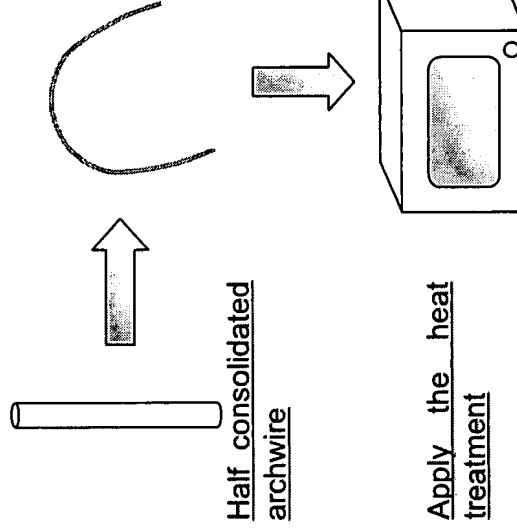
2

Apply heat using a soldering iron and extrude excess resin and voids.

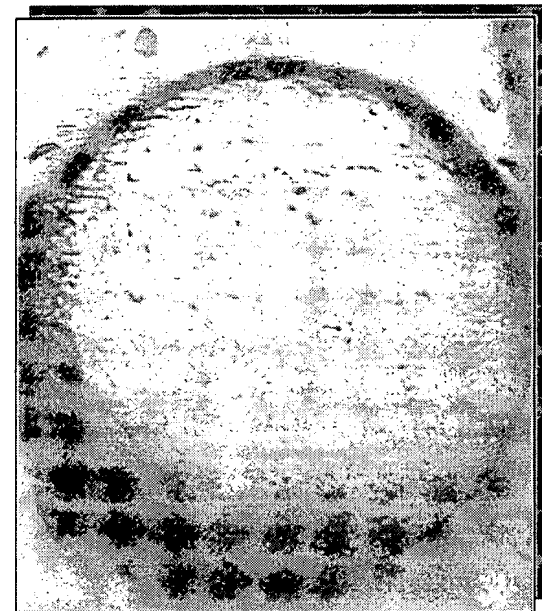


3

After 1 hour, archwire is fixed in the geometry of commercialized archwire, and then heat treatment is applied for 1 hour at 100 °C.

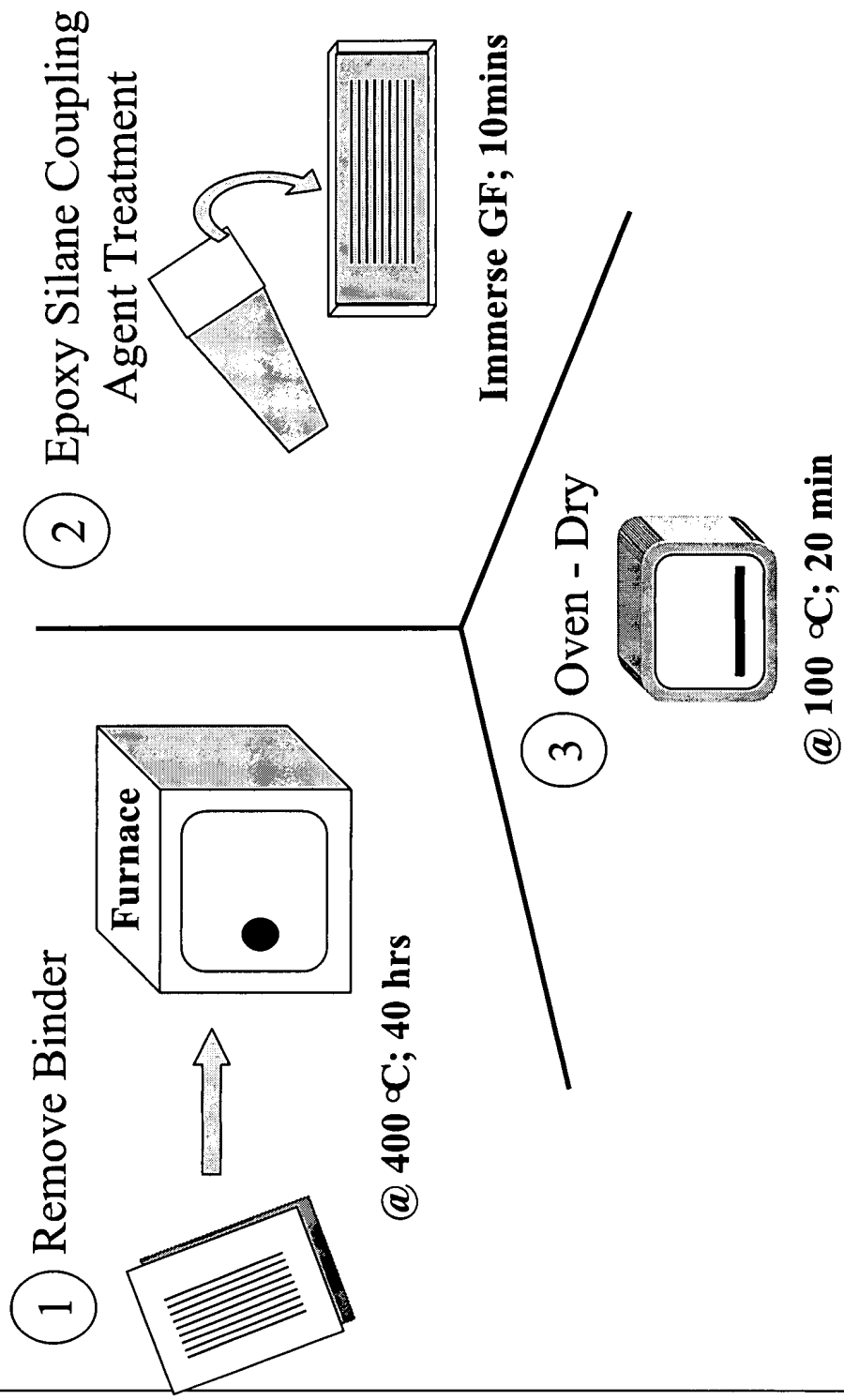


# CROSS-SECTION



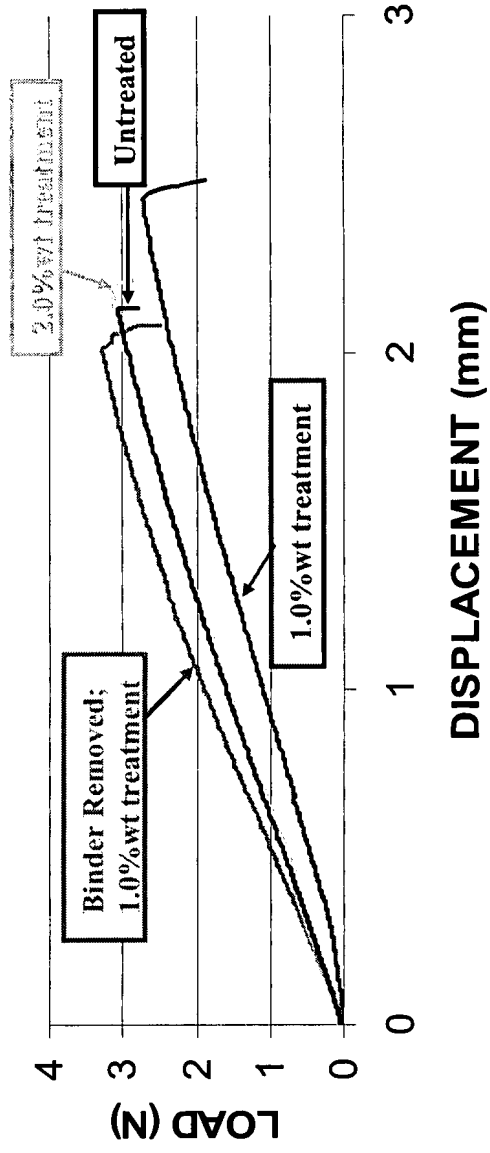
INSERT PICTURE OF SPECIMEN  
EPOXY RESIN

# SURFACE TREATMENT



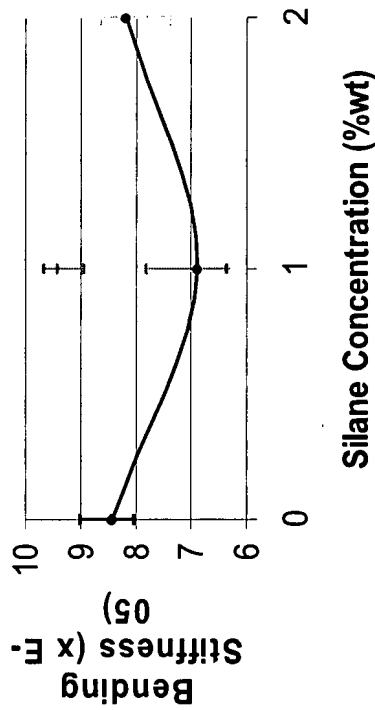
# TREATMENT EFFECTS

## Bending Characteristics

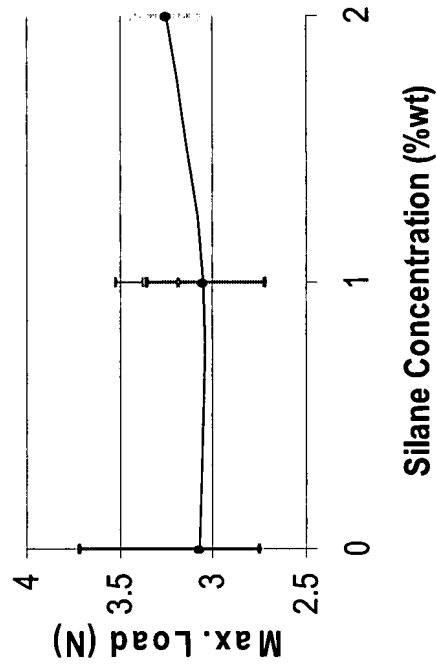


# TREATMENT EFFECTS

Fiber Surface Treatment Effect



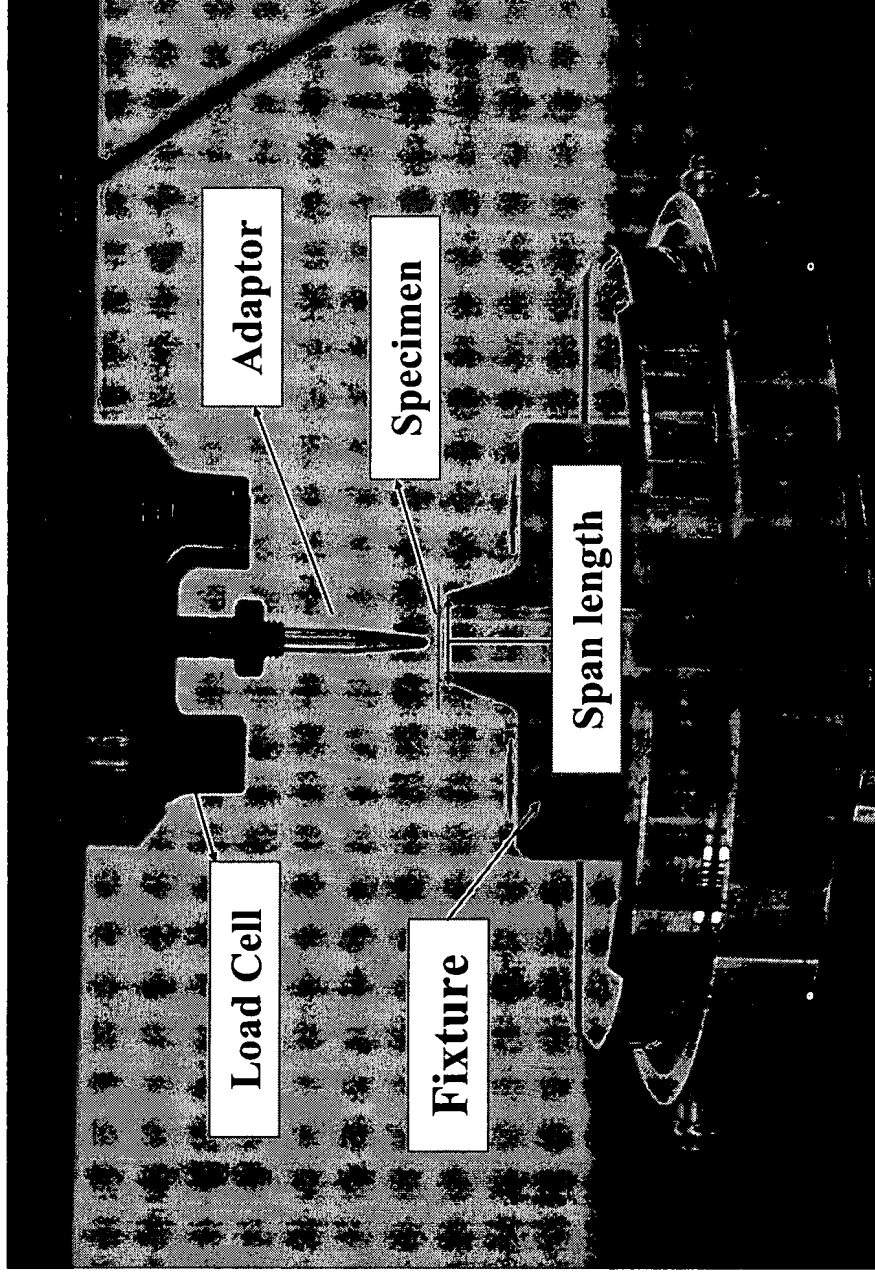
Fiber Surface Treatment Effect



- Untreated
- 1.0%wt treatment
- 2.0%wt treatment
- Binder Removed; 1.0%wt treatment

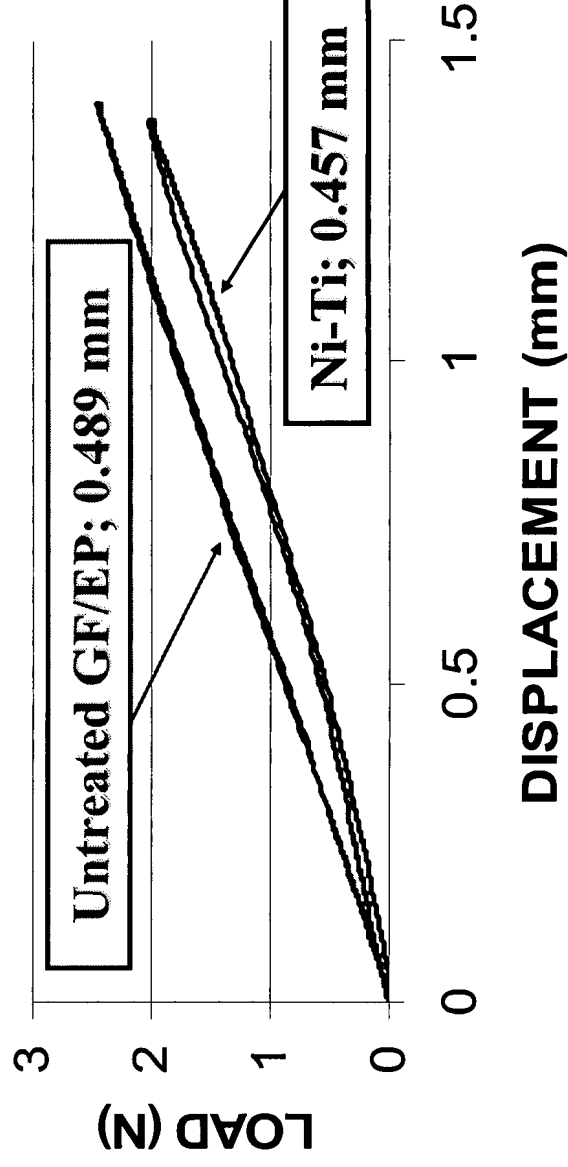
# Bending Test

# Fixture & Load cell Adaptor



# RECOVERY ANALYSIS

## Recovery Behaviour (Max. 1.4mm Displacement )

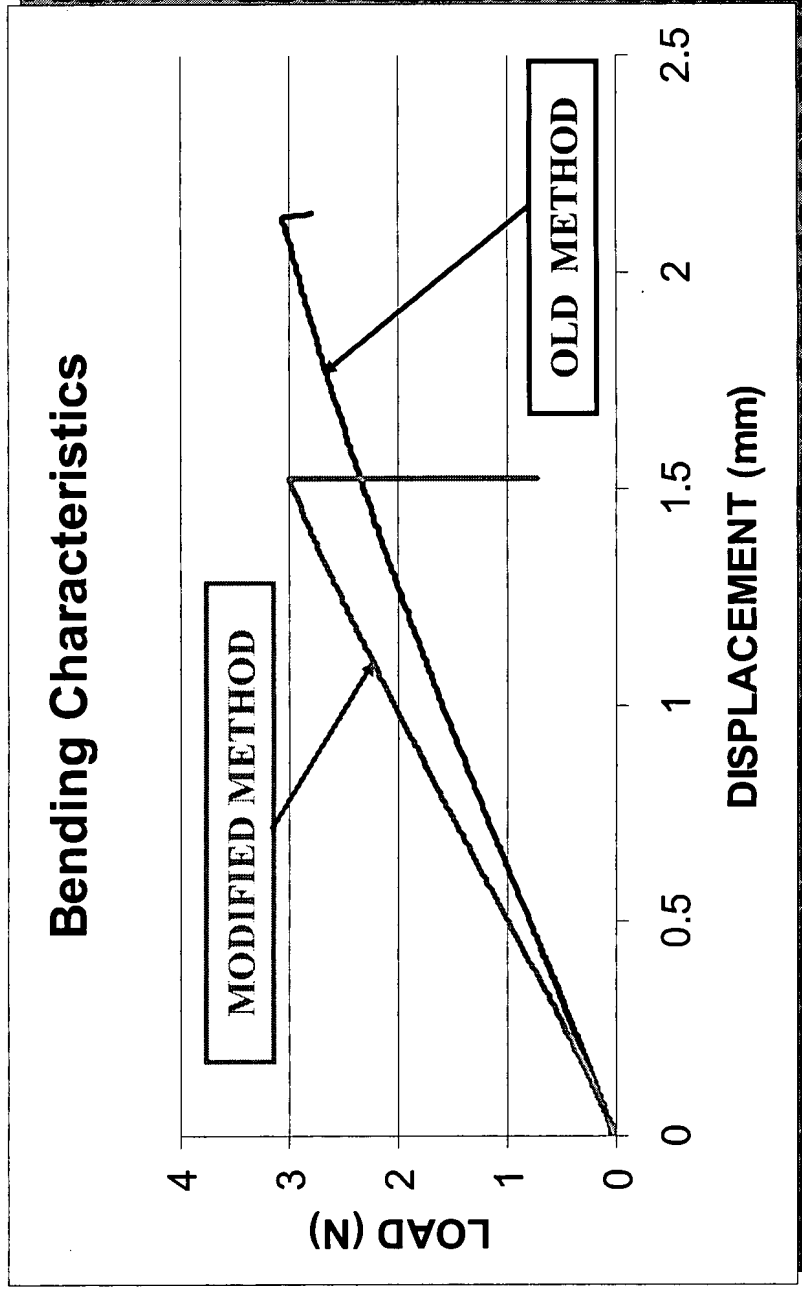


# MODIFICATION

- **BEFORE INSERTING GF INTO TUBE....**
  - Apply resin to GF
  - Squeeze impregnated GF
    - Similar to using rollers in pultrusion systems; better impregnation of resin.
  - Brush GF again and then insert into tube

# CROSS-SECTION

# BENDING CURVE



## **WORK PLAN.....**

- Verify the current modification (GF/EP)
  - If improvement observed, repeat all testing
- Treatment of GF
  - Increase the concentration of coupling agent
  - Determine the optimal concentration
- Increase the GF volume fraction
- Dental resin composite.

